THE UNIVERSITY OF ALBERTA

A COMPARISON OF THE 12-MINUTE AND 1000-METER RUN-WALKS AS TESTS OF THE AEROBIC POWER OF YOUNG MEN

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "A Comparison of the 12-Minute and 1000-Meter Run-Walks as Tests of the Aerobic Power of Young Men" submitted by Norman Frederick LaVoie in partial fulfilment of the requirements for the degree of Master of Arts.

ABSTRACT

The purpose of this study was to make a comparison of the 12-minute and 1000-meter run-walks as tests of the aerobic power of young men. Each of the practical tests was correlated with a Mitchell, Sproule, and Chapman Maximal Oxygen Intake Test which was employed as the best measure of cardio-respiratory fitness.

Twenty-three male volunteer students, between the ages of eighteen and twenty, participated in the study. All subjects attended the University of Alberta and were enrolled in the required service program. Each subject underwent a series of tests including: two 12-minute run-walk tests, two 1000-meter run walk tests, and a Mitchell, Sproule and Chapman MVO_2 test.

Correlation coefficients were obtained between the many variables by use of a zero order correlation matrix computer program which employed the Pearson product moment coefficient.

It was concluded that no significant differences, at the .05 and .01 levels of significance, occurred between the correlation coefficients obtained when the Mitchell, Sproule and Chapman test was correlated with the 12-minute run-walk and the 1000-meter run-walk tests. In addition both practical tests, the 1000-meter run-walk and the 12-minute run-walk

yielded very high reliability coefficients of .94 and .95 respectively, indicating that both tests are reliable measures.

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STATEMENT OF THE PROBLEM

INTRODUCTION

Fitness, today, is still an ill-defined and confusing word. To some people fitness connotes freedom from disease. Others measure fitness by the degree of muscular development as seen in weight lifting or gymnastics. Still others measure fitness by the number of pushups, situps, or chinups that can be performed by a person. Psychologists measure fitness by a person's psychological well-being.

Definitely fitness is all these things, but the term is still vague. Recently, in the field of physical education there has been an increasing recongnition that cardio-respiratory or endurance fitness is the best kind of physical fitness. Many investigators today are using maximum oxygen uptake as the ultimate measure of cardio-respiratory fitness. Among those upholding this theory are Astrand (5,6), Balke (7), Cooper (11), Taylor (32) and others.

The main disadvantages of the use of maximum oxygen uptake in general fitness programs are that the test requires elaborate equipment, facilities, personnel, and a great deal of time is consumed in administering such a test. It can

[illegible]

easily be seen that the test is very impractical for persons in the field handling large numbers of people. The answer to this problem is the development of a field test which will serve as a valid indicator or predicator of cardio-respiratory fitness.

The International Committee for the Standardization of Physical Fitness Tests has included as one of its fitness items, an endurance run to predict cardio-respiratory fitness (21). Men and boys 11 years and over run 1000 meters, women and girls 11 years and over run 800 meters, and children under 11 years are required to run 600 meters in the fastest time. At the last International Committee meeting in October 1968 at Mexico City, this item was criticized by Dr. Bruno Balke. He argued that a run of 10 to 18 minutes duration is required for the evaluation of the aerobic capacity or cardio-respiratory capacity (7).

Dr. Kenneth Cooper, a leader in the field of physiology of exercise, uses a 12-minute run-walk to evaluate a person's cardio-respiratory fitness. He has translated the maximum oxygen consumption treadmill test into a simple 12-minute run-walk test (11).

THE PROBLEM

The purpose of this study is to compare the values obtained in a maximal oxygen intake test with those obtained in a 12-minute run-walk and a 1000-meter run-walk and determine which of the latter tests is the best predictor of cardio-respiratory fitness. The tests to be used will be the Mitchell, Sproule and Chapman Maximal Oxygen Intake Test for determining maximal oxygen intake, a 12-minute run-walk for distance, and a 100-meter run-walk for time.

A correlation r_a will be obtained between the 12-minute run-walk and the Mitchell, Sproule and Chapman Test and a correlation r_b will also be obtained between the 1000-meter run-walk and the Mitchell, Sproule and Chapman Test.

MAIN HYPOTHESES

The null hypothesis asserts that no differences exist at the .05 level of significance between the correlations of the 12-minute run-walk and the Mitchell, Sproule and Chapman Test and of the 1000-meter run-walk and the Mitchell, Sproule and Chapman Test.

$$H_o : r_a = r_b$$

The alternate hypothesis asserts that differences do exist at the .05 level of significance between the correlations obtained from the two tests with the Mitchell, Sproule

and Chapman Test.

$$H_1 : r_a \neq r_b$$

SUBSIDIARY PROBLEM

A secondary problem will be to determine the reliability of both the 1000-meter run-walk and the 12-minute run-walk.

JUSTIFICATION FOR THE STUDY

Physical educators in the field must have a practical test that is reliable to evaluate the cardio-respiratory fitness.

Fitness today is of prime importance. People are interested in their physical well-being and want to be able to evaluate their own fitness using a simple test.

DELIMITATIONS OF THE STUDY

The study was limited to twenty-three first year university students attending the University of Alberta and enrolled in the first year required Physical Education program.

LIMITATIONS OF THE STUDY

The surface of the track used in the study. The linoleum at the corners of the arena track produced a slippery surface, making it difficult to run around the corners.

Temperature and humidity in the laboratory and arena were not controlled.

DEFINITION OF TERMS

Aerobic - the performance of physical exercise where the oxygen intake is sufficient and recovery keeps pace with activity.

Anaerobic - the performance of physical exercise where the oxygen cost per minute always exceeds the oxygen intake. During severe exercise, oxygen intake is inadequate to supply the oxygen requirement for production of the energy demanded, and the energy for muscular contraction is derived anaerobically from a complex series of chemical reactions.

Endurance Fitness - the ability to do prolonged work in the presence of a sufficient supply of oxygen without fatigue.

Maximal Oxygen Intake = Maximum Oxygen Uptake = Maximum Oxygen Consumption = MVO_2 - a test "of the maximal capacity of the cardiovascular-respiratory system to take up, transport and give off oxygen to the working tissues, and for these tissues to use the oxygen" (18).

CHAPTER II

REVIEW OF LITERATURE

THE MAXIMAL OXYGEN INTAKE

The capacity of an individual for doing hard muscular work can be expressed as the "aerobic" capacity or the maximal oxygen intake (2). The employment of maximal oxygen intake as a measure of cardio-respiratory fitness has been supported by many investigators (5,6,7,9,11,12,20,32).

According to Hettinger and his co-workers (20) maximal oxygen intake is the best measure of an individual's "physical fitness", but they add the proviso that the definition of "physical fitness" be restricted to the capacity of the individual to perform heavy work.

Taylor and Brozek (32) have labelled maximal oxygen intake as the best available test, on theoretical grounds, of the function of the cardiovascular-respiratory system, and they believe it to be a relatively constant characteristic of an individual and more indicative of true change in cardiovascular performance than other tests designed for the same purpose.

Astrand (5) states that "the individual's capacity for oxygen intake should be decisive in determing his ability to

sustain heavy, prolonged work".

Bock, et al. (9) believe that "the superiority of the athlete lies in his ability to meet the demand for oxygen".

Cumming and Danziger (12) state: "Probably the best available measure of the maximum working capacity of an individual is the maximal oxygen consumption".

Other investigators (17,25,31,33) give added support to maximal oxygen intake as a test of cardio-respiratory fitness but warn that the interpretations be based on standardized procedures.

Buskirk and Taylor report that of the several methods of expressing maximal oxygen intake, the most accepted method is milliliter of oxygen consumed per kilogram of total body weight per minute. In their discussion (15) they state that "if one considers the Max VO_2 technique as a procedure to be used in determining the fitness of an individual for tasks requiring exhausting running, body weight is the proper unit of reference. The ratio of Max VO_2 per kilogram of body weight provides a measure of the immediately available oxidative energy which can be supplied to move a kilogram of body weight from one point to another".

ESTIMATION OF MAXIMAL OXYGEN UPTAKE

In the past there have been many studies concerned with

the estimation of maximal O_2 uptake from other data. The two tests of interest in this study are the 1000-meter run-walk and the 12-minute run-walk.

The existing fitness test (21) upheld by the International Committee for the Standardization of Physical Fitness Tests (I. C. S. P. F. T.) has as one of its fitness items to measure cardio-respiratory, an endurance run. The "Endurance Run" includes three different distances to be run by the men, women and children. In all other ways it is identical. The distances run by men and boys 11 years and over is 1000 meters, women and girls 11 years and over 800 meters, and for children and under 11 years 600 meters.

SUPPORT OF THE ENDURANCE RUN

In a study by Falls, et al. (15), in which they investigated the validity of estimating maximal oxygen uptake from the AAHPER Youth Fitness Test items in adult subjects, they found that the best estimator of maximum O_2 uptake among the test items was the 600-yd. run-walk. They concluded that for the population studied, optimally-weighted Youth Fitness Test items appear to be about as good in estimation of maximum oxygen uptake per kg. body weight as the more specialized methods that have been reported in the literature.

OBJECTIONS TO THE ENDURANCE RUN

Many objectionswere posed at the 1968 I. C. S. P. F. T. at Mexico City concerning the endurance run as a measure of cardio-respiratory fitness.

Ullmark (21):

> "When you speak of endurance, it seems to be a little wrong to speak of a run of 1000 meters. It must be at least 10,000 meters, or a work-time of at least 30 minutes."

Simri (21):

> "We have serious doubts concerning the endurance run of 1000 meters for boys in the age group 12.6 - 15.0 (and especially in the group 12.6 - 14.0) as a result of our pilot study. I personally would prefer a longer distance, in which a 'steady state' is reached. 1500 meters turned out to be too short a distance for that purpose in our study."

Balke (21):

> "The distances of 1000, 800 and 600 meters respectively, are neither a measure of muscular nor of cardio-respiratory endurance.
>
> Thus, physiologically, the performance over these distances are rather meaningless. The 'muscular endurance' or anaerobic capacity is better evaluated with the 200 or 300 'sprint'.
>
> For the evaluation of the aerobic capacity, which is identical with the cardio-respiratory capacity, such a distance or duration for a run is required which minimized the influence of any performance. This can only be achieved in 'best efforts' of 10 to 18 minutes duration, the shorter time required for testing young or unfit groups, the longer time required for testing track athletes adequately. Thus, for age groups up to 12 years a 10 minute run-jog-walk is suggested; for all girls above 12 years and for boys from 12 to 14 a 12 minute run; and for males above 14 years of age a 15 minute running test.
>
> If one prefers fixed distances as technically more appropriate, 2000, 2400 and 3000 meters should be run, respectively."

SUPPORT OF THE 12 MINUTE RUN-WALK

Balke (7) examined the relationship of runs of 1 to 30 minutes in duration with maximal oxygen uptake. The maximal oxygen uptake was determined in a standardized treadmill test and then compared with the oxygen requirements estimated for average velocities achieved in best effort runs over various distances. It was found that the performances in runs of 12 to 20 minutes duration, expressed in amounts of required oxygen, matched the objectively measured aerobic capacity more closely. Only in runs of such a duration did the individuals settle down to an average pace which reflected most closely their aerobic work capacity. During the one minute of running a major portion of work was done anaerobically, and even in a 5 minute run it was found that a great part of the performance was accomplished in oxygen debt. However, it was also found that running longer than 20 minutes resulted in a performance inferior to that on the treadmill, averaging about 9 percent below the maximum capacity for oxygen intake.

Cooper (11) has devised a 12 minute test for people to ascertain their own levels of fitness. Essentially, the individual runs as far as he can on a measured course in 12 minutes. At the end of the run, after obtaining knowledge of

the distance covered, the individual can rate himself by the following chart:

Fitness Category		Distance Covered	Oxygen Consumption
Very Poor	I	less than 1.0 mile	28.0 ml/kg/min. or less
Poor	II	1.0 to 1.24 miles	28.1 to 34.0 ml.
Fair	III	1.25 to 1.49 miles	34.1 to 42.0 ml.
Good	IV	1.50 to 1.74 miles	42.1 to 52.0 ml.
Excellent	V	1.75 miles or more	52.1 ml/kg/min. or more

In an investigation by Doolittle and Bigbee (14), the 12-minute run-walk was evaluated as an   of cardio-respiratory fitness and compared with the 600-yard run-walk in the same regard. With nine grade 9 subjects maximum oxygen intake was correlated with the 12-minute run-walk and with the 600-yard run-walk which resulted in correlation coefficients of .90 and .62 respectively. They concluded that the 12-minute run-walk was a valid indicator of cardio-respiratory fitness and it was to be preferred to the 600-yard run-walk in this regard.

RELIABILITY OF THE TESTS

In a study by Willgoose et al. (37) a reliability coefficient of .92 was obtained for both girls and boys of the eight grade who performed the 600-yard run-walk item in the Youth Fitness Test of the American Association for Health, Physical Education and Recreation.

In a follow-up study by Askew (1) the reliability of the 600-yard run-walk was studied using students of eleventh grade age. Correlations of .65 and .76 were obtained for girls and boys respectively. It was concluded that the stress of the event limits personal motivation more at the senior high school level than at the junior high school level. Also, it was pointed out that to obtain the best possible results, senior high school students need more teacher motivation than junior high school students in taking the 600-yard run-walk test.

Doolittle (14) tested 153 grade 9 boys on a test-retest of the 12-minute run-walk. His results yielded a correlation of .94 as compared to the correlation coefficient of .92 as quoted by Askew (1). He concluded that both coefficients compare very favourably, but the higher validity of the 12-minute run-walk made it the preferable of the two.

CHAPTER III

METHODS AND PROCEDURES

SAMPLE

Twenty-three male volunteer students were used in this study. All students were attending the University of Alberta and were enrolled in the required Physical Education service program. All students were in the 18 to 20 year old age group.

ORDER OF TESTING

The two practical tests, the 12-minute run-walk and the 1000-meter run-walk, were conducted over a three week period by all subjects. The subjects were randomly divided into two groups of equal size for the testing. Each subject was paired with a member of the other group for recording purposes. The two groups performed different tests on each day of testing. There was a minimum of two days and a maximum of four days between the tests. Each test was performed twice by each subject.

All subjects performed a modified Mitchell, Sproule and Chapman Test as their last test in the two weeks following the practical testing. It was felt that the above procedure eliminated any training effect of the Mitchell, Sproule and Chapman Test since this test was the only test of the three in which

the subject went to exhaustion.

ORIENTATION PERIOD

Each subject was brought to the laboratory one to three days prior to the commencement of the Mitchell, Sproule and Chapman Test. At this time the subjects were given ample time to practice on the motor-driven treadmill and to become familiarized with the respiratory apparatus. The testing procedure was explained carefully and each subject was assigned a time for the actual test. The weight and age were recorded initially at this time. Each subject on his departure was told not to eat one and a half hour before the test because of the effect of the indigestion of food on pulse rate and cardiac output (23,33). Subjects were asked not to smoke for thirty minutes prior to the test and not engage in any strenuous work two hours before the test.

PHYSICAL CONDITIONS IN THE LABORATORY

The maximal oxygen intake can be affected by temperature variation when testing (28,33). Therefore, the temperature of the laboratory was standardized at 22 ± 2 degrees C. but the relative humidity was not controlled.

GAS COLLECTION AND ANALYSIS

A collins triple J valve was used to allow the subject

to breathe outside air and to expire only into a Douglas Bag. A rubber mouth-piece was fitted onto the valve and both were attached to a lightweight headgear which permitted easy attachment to the subject. The nose was clamped with a rubber nose clip. Expired air was analyzed for oxygen content with a Beckman E-2 oxygen analyzer, and for carbon dioxide with a Godart Capnograph. The volume of expired air was measured with a Parkinson Cowan volume meter.

CALIBRATION OF INSTRUMENTS

The gas analyzers were carefully calibrated prior to use each day and at regular intervals during the testing procedure. This calibration was completed with samples of known nitrogen and carbon dioxide content. The volume meter used was a Parkinson Cowan model with a 10 litre scale.

12-MINUTE RUN-WALK

The 12-minute run-walk was performed on the track circling the University of Alberta ice arena. The Track is an eight lap track and was divided into eights which were numbered from) to 7 with the starting point numbered 0. A stop watch was used to time the 12-minute duration and all subjects stopped running at the elapse of time when they heard the sound of a whistle. Subjects were notified of the

remaining time during the test. All subjects were instructed that this was an endurance test and therefore they would have to run at a pace they could maintain. They were instructed that walking was permissable if they could not continue running but to resume running at a faster pace after sufficient recovery. At the end of the 12-minute run-walk each runner's partner reported to the investigator the number of laps completed to the nearest eighth. The laps were converted into meters by the following formula:

$$\frac{\text{laps x 220.52 yds.}}{1.0936}$$

This same test was repeated a week later to estimate the reliability of the 12-minute run-walk. The subjects were instructed not to try and exceed the previous performance but to set a pace and do their best. The test was given in the same relative indoor temperature and time, and the same officials were used to check the subjects in both tests.

1000-METER RUN-WALK

All subjects were tested on a 1000-meter run-walk using the same track that was used in the 12-minute run-walk. Conditions were similar to those for the previous test. A 1000 meter run is 5 laps of the track minus 12.5895 yards. Therefore, the starting point was 0 as in the 12-minute run-

walk but the finishing point was 12.5895 yards back of it. All subjects were instructed that a pace would have to be set in order to finish the test. They were reminded that walking was permissable if they could not continue running, but it was pointed out that the object was to cover the distance in the shortest possible time. Each runner's partner stood behind the timekeeper in order to hear the time called out as the runner crossed the finish line. These times were recorded immediately after the run by the partner reporting to the timekeeper.

This same test was repeated a second time a week later to estimate the reliability of the 1000-meter run-walk. The test was administered under the same conditions.

MITCHELL, SPROULE AND CHAPMAN TEST

A test of maximal oxygen intake has been described by Mitchell, Sproule and Chapman (25). A modified version (35) of the test was performed for this study on a motor driven treadmill in the laboratory of the Physical Education building at the University of Alberta. Following are the procedures which were adhered to:

1. A 10 minute warm-up period was performed by each subject at 3 miles per hour at a 10 per cent grade, followed by a 10 minute rest period with the subject sitting down on a chair.

2. The first test run was carried out at 6 miles per hour and a 7½ per cent grade.

3. Before the treadmill was started, the subject was connected to a Collins triple J valve by means of a rubber mouthpiece and his nose was completely closed with a nasal clamp.

4. During the exercise runs at a speed of 6 miles per hour and lasting for 2.5 minutes, expired air was collected in a Douglas bag between one minute and 30 seconds and two minutes and 30 seconds of the run.

5. Analysis of the expired air was immediately carried out.

6. After a 10 minute rest period, the work load was increased by raising the grade 2½ per cent with the speed held constant at 6 miles per hour, and this same procedure was repeated until the oxygen intake measured in litres per minute levelled off or declined. The criterion for deciding whether maximal intake had been reached if the intake did not decline, has been determined by Mitchell, et al. (22, 25) to be a difference of less than 0.054 liters of oxygen per minute between two successive tests.

7. Partial gas samples were obtained during the last portion of a run at any level if the subject found it impossible to run the required 2.5 minutes.

STATISTICAL PROCEDURES

Validity and Reliability of Tests

The Mitchell, Sproule and Chapman Test is recognized, by authorities in the field of exercise physiology, as accurately measuring aerobic capacity. This Test is used as the criterion measure. The reliability of the 12-minute run-walk and the 1000-meter run-walk were investigated.

The reliability of the tests were estimated by the test-retest method.

The Pearson product-monent correlation was used in analyzing the validity and reliability (16).

Testing for Significant Differences

The significance of the difference between two correlation coefficients was estimated. The .05 level of significance was used in testing for significant differences.

CHAPTER IV

RESULTS AND DISCUSSION

CHARACTERISTICS OF TEST SUBJECTS

Twenty-three male volunteer subjects were used in this study. All students were enrolled at the University of Alberta and took part in the required physical education service program. Some characteristics of these subjects are given in Table I.

TABLE I

CHARACTERISTICS OF TEST SUBJECTS

	MEAN	STD. DEVIATION	RANGE
Age (yrs.)	18.74	$\pm$0.75	18 - 20
Weight (Kg.)	73.48	$\pm$8.53	61 - 97
MVO_2 (L/min)	3.08	$\pm$0.44	2.26 - 4.13
MVO_2 (ml/kg/min)	42.13	$\pm$5.15	35 - 54

The characteristics of the male subjects in this study are dissimilar to those used by Doolittle (14), Balke (7), and Cooper (11). In Doolittle's study the mean age was not given but was probably much lower since he used 153 Grade 9

boys. Balke's study involved a group of 34 high school students with a mean age of 15.9 years and a mean weight of 66 kg. In the same study another group of 9 was included with a mean age of 31.5 years and a mean weight of 79.6 kg. The mean age and weights of Cooper's study were not given but it was indicated that the subjects were officers and airmen. With this information one may presume that the mean age was higher.

RELIABILITY OF THE TESTS

The reliability of the 12-minute run-walk and of the 1,000-meter run-walk were calculated by the test-retest method. The Pearson product-moment correlation was used to obtain reliability coefficients. These values are given in Table II.

TABLE II

TEST RELIABILITY

TEST	r
1,000-METER RUN-WALK	.94
12-MINUTE RUN-WALK	.95

Both cases yielded correlation coefficients that are quite high and similar, indicating that both tests are highly

reliable measures. The correlation coefficient of .95 for the 12-minute run-walk substantiates a value of .94 that was previously reported by Doolittle (14).

In a study by Askew (1) it was found that to obtain the best possible results in administering the AAHPER 600-yd. run-walk, senior high school students need more teacher motivation than junior high school students. Reliability coefficients reported for senior high school boys and girls were .76 and .65 respectively and .92 for both junior high school boys and girls.

In the present study every attempt was made to insure that equal motivation was given for each test. The reliability of the Mitchell, Sproule and Chapman Maximal Oxygen Intake test was not tested in this study. However, in a study in the same laboratory by Macnab, Conger and Taylor (24) the year preceding this study a reliability coefficient of .88 was obtained on a group of males with a mean age of 19.97 years, a range of 18.33 to 22.42, and a mean weight of 76.10 kg.

RESULTS OF TESTS

The mean scores of all test results are given in Table III.

The present study produced lower mean values for the maximal oxygen intake test than others reported previously.

TABLE III

MEAN SCORES OF TEST RESULTS

	MEAN	STD. DEVIATION	RANGE
Mitchell, Sproule & Chapman (L/min)	3.08	$\pm$ 0.44	2.26 - 4.13
Mitchell, Sproule & Chapman (ml/kg/min)	42.13	$\pm$ 5.15	35 - 54
1,000-meter run-walk (sec) TRIAL 1	224.57	$\pm$ 16.27	196 - 256
1,000-meter run-walk (sec) TRIAL 2	227.70	$\pm$ 21.27	190 - 278
12-minute run-walk (meters) TRIAL 1	2572.04	$\pm$ 300.47	1916 - 3075
12-minute run-walk (meters) TRIAL 2	2632.22	$\pm$ 235.08	2168 - 3049
Velocity of 12-minute run-walk (m/sec) TRIAL 1	214.26	$\pm$ 25.07	159.7 - 256.3
Velocity of 12-minute run-walk (m/sec) TRIAL 2	219.36	$\pm$ 19.59	180.7 - 254.1

TABLE IV

MAXIMAL OXYGEN UPTAKE IN MEN & WOMEN

Study		N	Age	Wt (kg)	liters/min	ml/kg per min	ml/kg fat free wt/min
Metheny	♀	17	20 - 27			40.90	
(1942)	♂	30	19 - 23			51.30	
% Difference						25	
Astrand	♀	44	20 -25	60.30	2.90	48.40	
(1952)	♂	42	20 - 33	70.40	4.11	58.60	
% Difference				17	43	21	
von DoBeln	♀	34	19 - 30	62.80	3.06 *	49.35	61.20
(1956)	♂	35	19 - 40	69.30	3.91 *	56.66	63.26
% Difference				10	28	15	3
Hermansen and Andersen	♀	12	21 - 24	61.10	2.30	38.00	
(1965)	♂	12	19 - 29	73.10	3.20	44.00	
% Difference				20	40	16	
Holmgren	♀	10	(Described		2.59		
(1967)	♂	10	as young adult)		3.94		
% Difference					52		
Macnab, Conger and Taylor	♀	24	18 - 20	59.24	2.32	39.06	50.42
(1968)**	♂	24	18 - 22	76.10	3.92	51.71	59.41
% Difference				28	69	32	17

Macnab, Conger and Taylor (1968)***	♀	24	18 - 20	59.24	2.12	35.67	46.87
	♂	24	18 - 22	76.10	3.52	46.47	53.31
% Difference				28	66	30	14

*   indirect measure
** Treadmill
*** Bicycle

By referring to Table IV prepared by Macnab, Conger & Taylor (24) it can quite clearly be seen that Metheny, Astrand, von Dobein, Hermansen and Andersen, Holmgren, and Macnab, Conger and Taylor all report higher MVO_2 values for male subjects.

The samples in the studies of Metheny, Hermansen and Andersen were selected from a university population. The subjects in Astrand's study consisted of physical education students. von Dobeln's sample was comprised of physical education students and teachers, while Holmgren's sample was described only as young adults.

The sample in the present study was comprised of students in faculties other than physical education and therefore was probably a more random sample of the university population than the other studies cited. This could explain the lower MVO_2 values.

Table V shows a comparison of the results of this study with the chart below, developed by Cooper (11) for the estimation of maximal oxygen uptake.

FITNESS CATEGORY	DISTANCE COVERED	OXYGEN CONSUMPTION
Very Poor I	less than 1.0 mile	28.0 ml/kg/min or less
Poor II	1.0 to 1.24 miles	28.1 - 34.0 ml.
Fair III	1.25 to 1.49 miles	34.1 - 42.0 ml.

Good IV	1.50 to 1.74 miles	42.1 - 52.0 ml.
Excellent V	1.75 miles or more	52.1 ml/kg/min or more

In all cases where there was a deviation from Cooper's categories the predicted MVO_2 was an overestimation of the subject's actual MVO_2. However, in most cases the deviation was not gross with the exception of four or five subjects.

Balke (7) along with Astrand (3) and Henry (19) found that the amounts of oxygen required for velocities between .133 m/min (5 m.p.h.) and about 290 m/min. (11 m.p.m.) were linearly related to the running performance. The results of this study show that the velocities of the 23 subjects used were between 159.7 m/min. and 256.3 m/min.

CORRELATION ANALYSIS OF THE MITCHELL, SPROULE AND CHAPMAN MAXIMUM OXYGEN INTAKE TEST WITH THE 12-MINUTE RUN-WALK AND THE 1,000-METER RUN-WALK

The main objective of the present study was to make a comparison between the correlation coefficients obtained when the two practical tests were correlated with a maximum oxygen intake test, and to determine which of the former tests was most closely related to cardio-respiratory fitness.

The correlation coefficients were calculated by the Pearson product-moment method using a computer zero-order correlation matrix. These coefficients are given in Table VI.

TABLE V

A COMPARISON OF THE ACTUAL MVO_2

CALCULATED WITH COOPER'S CHART

FOR ESTIMATING MVO_2

SUBJECT	ACTUAL MVO_2 (ml/kg/min)	ESTIMATED MVO_2 (ml/kg/min)
S1	35	34.1 - 42
S2	40	42.1 - 52
S3	39	42.1 - 52
S4	47	52.1 or more
S5	46	42.1 - 52
S6	42	42.1 - 52
S7	45	52.1 or more
S8	39	42.1 - 52
S9	44	42.1 - 52
S10	40	52.1 or more
S11	41	42.1 - 52
S12	54	52.1 or more
S13	42	42.1 - 52
S14	42	42.1 - 52
S15	36	42.1 - 52
S16	38	42.1 - 52
S17	43	42.1 - 52
S18	53	52.1 or more
S19	41	42.1 - 52
S20	37	34.1 - 42
S21	39	34.1 - 42
S22	50	42.1 - 52
S23	36	42.1 - 52

TABLE VI

COMPARISONS OF THE CORRELATION

COEFFICIENTS

	1	2	3	4	5	6	7	8
1. MVO_2 L/min.	--	.65	-.38	-.44	.31	.23	.32	.23
2. MVO_2 ml/kg/min.		--	-.66	-.74	.68	.61	.68	.61
3. 1000 m(sec) T_1			--	.94	-.89	-.83	-.89	-.83
4. 1000 m(sec) T_2				--	-.92	-.89	-.92	-.89
5. 12 min (m) T_1					--	.95	1.000	.95
6. 12 min (m) T_2						--	.95	1.000
7. 12 min (m/min) T_1							--	.95
8. 12 min (m/min) T_2								--

After inspecting Table VI it can readily be seen that both positive and negative coefficients are in evidence. Before we proceed any further this must be explained.

The negative correlation coefficients of MVO_2 in both L/min and ml/kg/min with the 1,000-meter run-walks indicates that the subject with the higher MVO_2 value completed the 1,000-meter run-walks in the fastest times. On the other hand the positive correlation coefficients of MVO_2 with the 12-minute run-walks indicates that the subject with the higher

MVO_2 covered the farther distances. Thus for comparison purposes the signs of the coefficients may be reflected.

The correlations of the run-walk tests with body weight, and MVO_2 in ml/kg/min and in liters/min are given in Table VII.

TABLE VII

CORRELATIONS OF RUN-WALK TESTS WITH

BODY WEIGHT AND WITH MVO_2

in liters/min. and in ml/kg/min.

	1000 METER TRIAL 1	1000 METER TRIAL 2	12 MINUTE TRIAL 1	12 MINUTE TRIAL 2
BODY WEIGHT	.25	.23	-.30	-.31
MVO_2, L/min	-.38	-.44	.31	.23
MVO_2, ml/kg/min	-.66	-.74	.68	.61

The positive correlations of body weight with the 1,000-meter run-walks indicates that in general the heavier the subject the longer it takes for the subject to complete the test. The negative correlations of body weight with the 12-minute run-walks indicates that the heavier subject covers the less distance in the test. Therefore once again for comparison purposes the sign of the coefficient may be ignored.

The correlations of MVO_2 with both tests are greater when the MVO_2 is expressed in ml/kg/min. This is due to the fact that heavier people have a higher MVO_2 because of a larger lung capacity and an increased demand for oxygen. When the effect of this increased size above is compensated for a true picture of MVO_2 as a reflection of "fitness" emerges.

Since the heavier subject takes longer to complete the 1,000-meter run-walk and travels the less distance in the 12-minute run-walk and his MVO_2 is lower when translated into ml/kg/min, the correlations between MVO_2 in ml/kg/min with both of the practical tests will be much higher than those of MVO_2 in L/min with the practical tests.

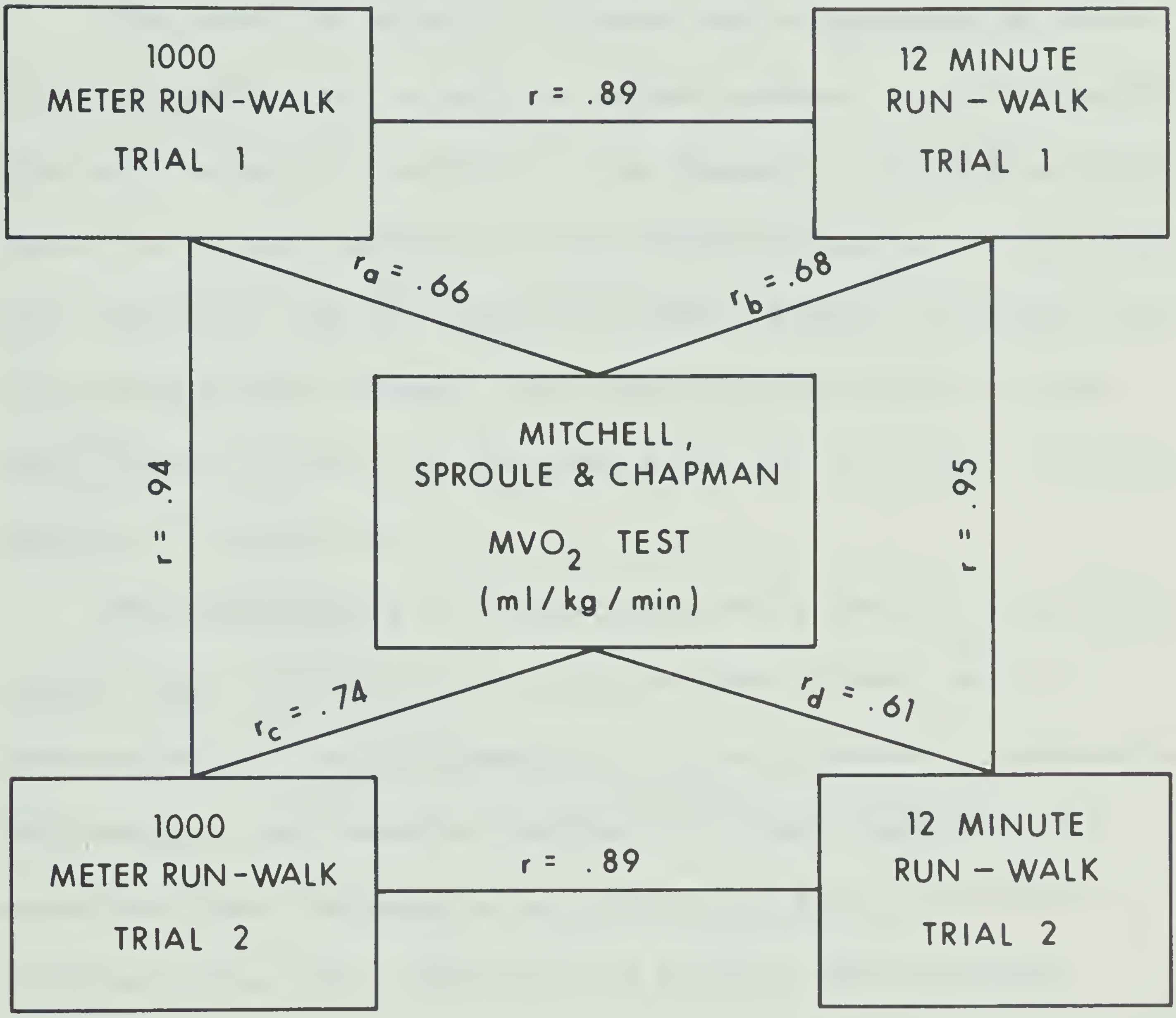
To reiterate, when comparing the correlation coefficients in the present study the signs of the coefficients have been reflected since the lowest time was used for the best score in the 1,000-meter run-walk.

Figure I illustrates and compares the correlation and reliability coefficients that existed between the tests.

In order to test the null hypothesis that $r_a = r_b$ ($_a$ = $_b$) a t-test described by Walker and Lev (8) was used. No significant differences were found (P = .01) when the correlation coefficients were tested. No significant differ-

FIGURE I

THE CORRELATION COEFFICIENTS BETWEEN THE TESTS



Note: The signs of the coefficients have been reflected since the lowest time was used to represent the best score in the 1000-meter run-walk.

ences were found when the correlation coefficients r_c and r_d were tested (P = .01).

DISCUSSION

The state of physical fitness can be assessed by determining an individual's maximum oxygen uptake or work capacity. This work capacity consists of two phases: the aerobic phase, where the oxygen intake is sufficient and recovery keeps pace with activity, and the anaerobic phase, where the oxygen cost per minute always exceeds the oxygen intake and the oxygen requirements are met by the body's ability to incur a certain amount of oxygen debt.

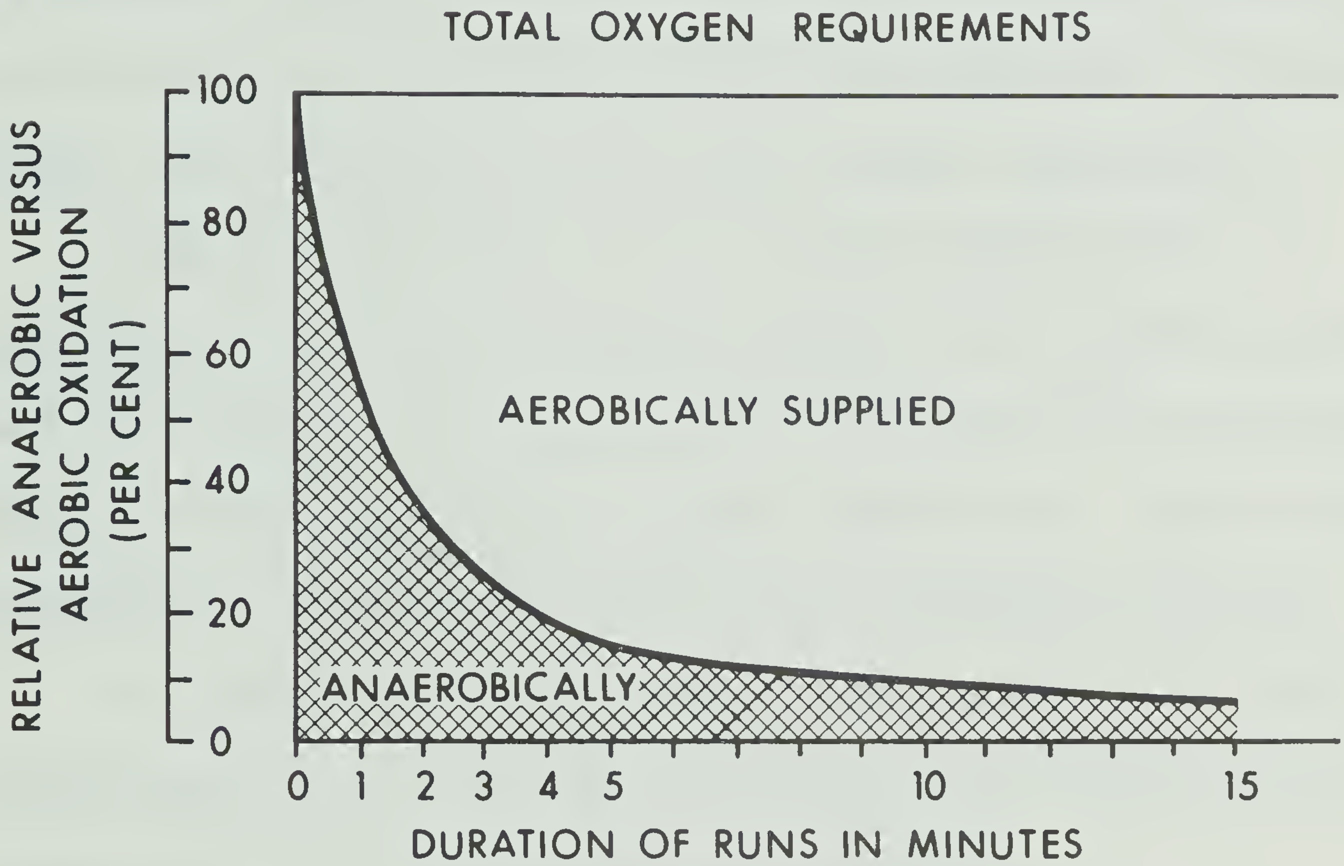
The performance of exercises such as the 100 yard dash require near all-out efforts and are done almost entirely anaerobically. As the length of the work period increases in performing a task such as running, the less important the anaerobic phase becomes in accomplishing such a task and conversely the more important the aerobic phase becomes.

Figure II from an article of Balke's (7) illustrates the relative role of anaerobic and aerobic oxidation for supplying the total amounts of oxygen required during best-effort runs of defined time intervals.

It can readily be seen from Figure II that efforts of very short duration are done almost entirely anaerobically

FIGURE II

THE ROLE OF ANAEROBIC AND AEROBIC OXIDATION



and conversely efforts of relatively long duration become more aerobic.

It is Balke's contention that since only the assessment of the aerobic work capacity is useful as a realistic measure of the potentially available functional reserves, the duration of a physiologically meaningful field test should be at least 12 minutes. Under this hypothesis the 1,000-meter run-walk is too short of a run and therefore the oxygen debt capacity covers over 20 percent of the total oxygen requirements.

The main hypothesis in this study asserted that no significant differences existed between the 12-minute run-walk and the 1,000-meter run-walk when correlated with the Mitchell, Sproule and Chapman Maximum Oxygen Intake Test. The alternate hypothesis asserted that significant differences existed.

No significant differences at the .05 and .01 levels of significance were found when the correlation coefficients were tested and the main hypothesis was accepted.

Referring again to Figure II there appears to be little difference between the 1,000-meter run-walk and the 12-minute run-walk. The average time to complete the 1,000-meter run-walk was 3 minutes and 46 seconds. The difference between the two tasks is only about 10 percent.

On the basis of this investigation it appears that the distance an individual can cover by running and/or walking

in 12 minutes is a no more reliable or valid indicator of cardio-respiratory fitness than the time to run and/or walk 1,000 meters.

CHAPTER V

SUMMARY AND CONCLUSIONS

SUMMARY

It was the purpose of this study to make a comparison between the values obtained in a Mitchell, Sproule, and Chapman Maximal Oxygen Intake Test and two practical tests, the 12-minute run-walk and the 1,000-meter run-walk, and determine which of the latter tests was the best predictor of cardio-respiratory fitness.

Twenty-three male volunteer students, between the ages of eighteen and twenty, were used as subjects in this investigation. All attended the University of Alberta and participated in the required physical education service program.

Each subject performed all tests. The 12-minute run-walk test and the 1,000-meter run-walk test were conducted over a three-week period. The subjects were randomly divided into two groups of equal size for the testing. One group would perform one of the practical tests on a certain day, while the other group would perform the other practical test on the same day.

The tests were alternated and performed twice by each

subject. There was a minimum of two days and a maximum of four days between the tests.

In the two weeks following the end of the practical testing each subject performed a modified Mitchell, Sproule and Chapman Maximal Oxygen Intake test in the Physical Education laboratory.

Correlation coefficients were obtained between all variables by use of a zero order correlation matrix computer program which employed the Pearson product-moment coefficient. Certain of these coefficients were used to analyze the validity and reliability of the 12-minute run-walk and the 1,000-meter run-walk. In testing for significant differences the formula for the significance of the difference between two correlation coefficients for correlated samples was used (16).

CONCLUSIONS

Within the limitations of this study, the following conclusions were made:

1. There was no significant difference between the correlation coefficients obtained by correlating the Mitchell, Sproule and Chapman test with the 12-minute run-walk and the 1,000-meter run-walk tests.

2. Both practical tests,the 1,000-meter run-walk and the 12-minute run-walk, yielded very high reliability coefficients

of .94 and .95 respectively.

3. Cooper's chart (11) seemed to be of some practical use in predicting cardio-respiratory fitness. However, there appeared to be an overestimation of some of the subjects' maximal oxygen intake when their maximal oxygen intake was estimated from the distance travelled by a subject in the 12-minute run-walk test.

RECOMMENDATIONS

That studies of other age groups be carried out for both men and women.

That a set of norms be developed for the 1,000 meter run-walk test.

That a study be carried out on the use of the 12-minute run-walk test in adult fitness programs. For those in poor or average condition the 12-minute run-walk is a very demanding test.

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APPENDICES

APPENDIX A

STATISTICAL PROCEDURES

AND SAMPLE CALCULATION SHEET

ZERO ORDER CORRELATION MATRIX-PE557205

Correlation matrices of up to 56 variables can be computed at any one time. The output consists of the means and standard deviations of the variables, followed immediately by the inter-correlation matrix. The only restriction is that there must be an equal number of observations for all pairs of variables entering into the correlation coefficients.

INPUT

STEPS

(1) CARD I - (Col. 1-2), number of matrices to be computed (I2).

(2) CARD II - (Col. 1-4), number of observations (I4); (Col. 5-8), number of variables (I4).

(3) CARD III - (Col. 7-72), the format of the variables as they appear on the data cards. This format must be enclosed in parentheses with the left parenthesis appearing in Col. 7. All input must be in F format.

(4) DATA CARDS - according to the format specifications required by CARD III.

When the number of matrices to be computed exceeds one, --repeat steps 2, 3, and 4, for each matrix.

O/S REQUIREMENTS

```
       Col.1

1.     //PE557205_JOB_(705024,1,1),'CORR_',MSGLEVEL=1

2.     //MATCORR_EXEC_FORTHCLG

3.     //FORT.SYSIN__DD__*

4.     Mainline program.

5.     /*

6.     //GO.SYSIN__DD__*

7.     INPUT AS DESCRIBED ABOVE

8.     /*
```

TESTS OF SIGNIFICANCE

H_o: 35 = 37 H_1: 35 $\neq$ 37

=.05. .01

d.f. = N - 3 = 20

Decision Rule: Reject H_o if-2.086 t 2.086

Reject H_o if -2.845 t 2.845

Do not reject H_o if -2.086 t 2.086

Do not reject H_o if -2.845 t 2.845

Computation: 35 = .38; 37 = .31; 57 = .89

$$t = \frac{(r_{12} - r_{13})\overline{(N-3)(1 + r_{23})}}{\overline{2(1 - r_{12}{}^2 - r_{13}{}^2 - r_{23}{}^2 + 2r_{12}\, r_{13}\, r_{23}}}$$

$$= \frac{(.38 - .31)(6.15)}{.5993}$$

$$= .7183$$

Decision: Accept H_o P .20

No significant difference

where 3 represents MVO_2 in L/min
5 represents 1000-meter run-walk T_1
7 represents 12-minute run-walk T_1

H_o : 45 = 47 H_1: 45 $\neq$ 47

= .05, .01

d.f. = 20

Decision Rule: Reject H_o if -2.086 t 2.086

Reject H_o if -2.845 t 2.845

Do not reject H_o if -2.086 t 2.086

Do not reject H_o if -2.845 t 2.845

Computation: 45 = .66; 47 = .68; 57 = .89

$$t = \frac{(.66 - .68)(6.15)}{.469}$$

$$= -.2622$$

Decision: Accept H_o

45 = 47 P .20

No significant difference

where 4 represents MVO_2 in Ml/kg/min
5 represents 1000-meter run-walk T_1
7 represents 12-minute run-walk T_1

H_o: 46 = 48 H_1: 46 ≠ 48

= .05, .01

d.f. = 20

Decision Rule: Reject H_o if -2.086 t 2.086

Reject H_o if -2.845 t 2.845

Do not reject H_o if -2.086 t 2.086

Do not reject H_o if -2.845 t 2.845

Computation: 46 = .74; 48 = .61; 68 = .89

$$t = \frac{(.74 - .61)(6.15)}{.4242}$$

$$= 1.8847$$

Decision: Accept H_o

46 = 48 .15 P .10

No significant difference

where 4 represents MVO_2 in ml/kg/min
6 represents 1000-meter run-walk T_2
8 represents 12-minute run-walk T_2

H_o: 25 = 27 H_1: 25 = 27

= .05, .01

d.f. = 20

Decision Rule: Reject H_o if -2.086 t 2.086

Reject H_o if -2.845 t 2.845

Do not reject H_o if -2.086 t 2.086

Do not reject H_o if -2.845 t 2.845

Computation: 25 = .25; 27 = .30; 57 = .89

$$t = \frac{(.25-30)(6.15)}{.6164}$$

$$= -.4987$$

Decision: Accept H_o

25 = 27 P .20

No significant difference

where 2 represents body weight in Kg

5 represents 1000-meter run-walk T_1

7 represents 12-minute run-walk T_1

GAS ANALYSIS COMPUTATION

NAME:

AGE:

WEIGHT:

DATE:

TEMPERATURE:

BAROMETRIC PRESSURE:

FACTOR:

TREADMILL INCLINATION:

$\% \ O_{2E} = .\_\_\_\_\_\_ \times 2.5 = \_\_\_\_\_\_\_\%$

$\% \ CO_{2E} = \_\_\_\_\_\_\_\%$

$\% \ N_{2E} = 100 - \_\_\_\_\_\_\_\% \ O_{2E} - \_\_\_\_\_\_\_\% \ CO_{2E} = \_\_\_\_\_\_\_\%$

V_EATPS = ________ L/Min.

(partial to whole sample ATPS = ____ x ____ L. = ____ L/Min.)

V_E STPD = ____ (factor) x _____ L/Min. = _______ L/Min.

$V_1 \text{ STPD} = \_\_\_\_\_\_ V_E \text{ STPD} \times \dfrac{\_\_\_\_\_\_\% \ N_{2E}}{79.04} = \_\_\_\_\_\_\_\_\_\_ \text{ L/Min.}$

$VO_2 = (\_\_\_\_ V_1 \text{ STPD} \times .2093) - (\_\_\_\_\_\_ V_E \text{ STPD} \times .\_\_\_\_\_\_ O_{2E})$

$= \_\_\_\_\_\_$ L/Min. Oxygen Uptake.

APPENDIX B

CORRELATION MATRIX

CORRELATION MATRIX

	1	2	3	4	5	6	7	8	9	10
1	1.00	-.079	-.085	-.049	.139	.021	-.123	-.020	-.124	-.019
2	-.079	1.00	.569	-.248	.247	.227	-.295	-.314	-.288	-.314
3	-.085	.569	1.00	.648	-.375	-.438	.312	.228	.317	.228
4	-.049	-.248	.648	1.00	-.663	-.737	.675	.605	.675	.605
5	.139	.247	-.375	-.663	1.00	.938	-.888	-.834	-.887	-.833
6	.021	.227	-.438	-.737	.938	1.00	-.924	-.892	-.922	-.892
7	-.123	-.295	.312	.675	-.888	-.924	1.00	.948	1.00	.948
8	-.020	-.314	.228	.605	-.834	-.892	.948	1.00	.948	1.00
9	-.124	-.288	.317	.675	-.887	-.922	1.00	.948	1.00	.948
10	-.019	-.314	.228	.605	-.833	-.892	.948	1.00	.948	1.00

where 1 - Age
2 - Weight
3 - MVO_2 L/Min.
4 - MVO_2 ml/kg
5 - 1000-meter run-walk T_1
6 - 1000-meter run-walk T_2
7 - 12-minute run-walk T_1
8 - 12-minute run-walk T_2
9 - Velocity of 12 min. run-walk m/min T_1
10 - Velocity of 12 min. run-walk m/min T_2

APPENDIX C

RAW SCORES

RAW SCORES - MITCHELL, SPROULE & CHAPMAN TEST

SUBJECT	% TREADMILL INCLINATION	% OXYGEN	% CARBON DIOXIDE	VOL. EXP. S.T.P.D.	OXYGEN UPTAKE Litres/minute
01	7½	17.63	5.70	80.38	2.15
	10	18.08	4.80	96.21	2.26
02	7½	17.63	5.30	84.42	2.35
	10	17.78	5.00	96.18	2.57
	12½	17.95	4.80	95.76	2.40
03	7½	17.18	6.20	84.34	2.62
	10	17.88	5.50	97.70	2.36
	12½	17.75	5.50	106.46	2.74
04	7½	15.88	7.60	61.64	2.70
	10	15.80	7.50	71.64	3.23
	12½	15.88	7.40	79.14	3.51
	15	16.75	6.40	91.63	3.30
	17½	17.15	5.80	107.87	3.51
05	7½	16.68	6.50	77.96	2.86
	10	17.28	5.60	102.30	3.22
	12½	17.70	5.10	123.75	3.39
	15	17.70	4.90	126.23	3.53
06	7½	17.25	6.20	85.90	2.60
	10	17.38	5.60	90.86	2.74
	12½	18.00	4.90	118.53	2.86
07	7½	16.13	6.70	68.15	2.93
	10	16.38	6.80	76.41	3.03
	12½	17.15	6.10	92.51	2.93

SUBJECT	% TREADMILL INCLINATION	% OXYGEN	% CARBON DIOXIDE	VOL. EXP. S.T.P.D.	OXYGEN UPTAKE Litres/minute
08	7½	17.00	6.20	86.84	2.90
	10	17.65	5.20	102.55	2.85
	12½	18.10	4.60	123.22	2.92
	15	18.43	4.10	126.53	2.64
09	7½	17.83	5.30	85.68	2.17
	10	17.70	5.10	95.76	2.63
	12½	17.93	4.20	110.38	2.97
10	7½	16.75	7.10	72.31	2.47
	10	16.50	6.70	79.42	3.05
	12½	17.20	6.30	92.80	2.84
	15	17.43	5.40	94.47	2.84
11	7½	17.05	5.50	74.70	2.58
	10	17.25	5.00	85.49	2.85
	12½	17.80	4.60	92.96	2.56
12	7½	16.50	6.00	83.33	3.35
	10	16.63	5.90	90.75	3.51
	12½	16.98	5.80	106.43	3.69
	15	16.88	6.10	107.25	3.77
13	7½	16.60	6.80	86.21	3.17
	10	17.30	5.50	103.04	3.24
	12½	17.75	4.80	110.84	3.06
14	7½	16.53	6.50	84.65	3.26
	10	16.75	6.00	88.51	3.28

SUBJECT	% TREADMILL INCLINATION	% OXYGEN	% CARBON DIOXIDE	VOL. EXP. S.T.P.D.	OXYGEN UPTAKE Litres/minute
15	7½	17.45	5.90	80.35	2.29
	10	17.83	4.90	92.07	2.43
	12½	18.08	4.40	97.51	2.39
16	7½	17.45	5.50	98.47	2.91
	10	18.00	4.80	112.71	2.75
17	7½	17.50	5.50	94.11	2.72
	10	17.25	5.90	101.28	3.14
	12½	18.25	4.30	132.93	3.00
18	7½	15.95	7.20	62.29	2.74
	10	15.95	7.40	69.71	3.03
	12½	16.58	6.40	84.98	3.24
19	7½	17.05	6.30	71.75	2.33
	10	17.05	5.70	73.80	2.51
20	7½	17.25	6.00	95.03	2.92
	10	18.05	4.20	121.10	3.07
21	7½	17.25	6.40	100.43	2.98
	10	17.83	4.80	127.41	3.39
	12½	18.30	3.80	136.12	3.17
22	7½	16.55	6.60	83.72	3.18
	10	16.63	6.20	101.21	3.85
	12½	17.05	6.00	120.37	4.00
	15	17.30	5.60	132.45	4.13

SUBJECT	% TREADMILL INCLINATION	% OXYGEN	% CARBON DIOXIDE	VOL. EXP. S.T.P.D.	OXYGEN UPTAKE Litres/minute
23	7½	16.75	7.50	101.38	3.35
	10	17.43	6.00	122.99	3.50

RAW SCORES - 12-MINUTE RUN-WALK (LAPS) AND

1000-METER RUN-WALK (TIME)

*ran 12 minute tests first

SUBJECT	LAPS	TIME	LAPS	TIME
* 01	9½	4:12	10 3/4	4:38
* 02	13¼	3:34	13 3/4	3:40
03	12	4:03	12 1/8	4:00
* 04	14 9/16	3:16	14 5/8	3:10
* 05	13¼	3:37	13	3:36
* 06	12 3/4	3:49	13 1/8	3:57
* 07	14	3:42	14 3/8	3:32
* 08	13 3/8	3:38	13 ¼	3:39
* 09	12 7/8	3:47	12¼	3:51
10	15 1/16	3:17	14 7/8	3:16
11	13¼	3:39	14 1/8	3:41
12	15	3:28	14 7/8	3:16

SUBJECT	LAPS	TIME	LAPS	TIME
13	11 15/16	3:51	12 1/8	3:58
* 14	12¼	3:48	12 7/8	3:48
* 15	12¼	3:45	12 7/8	3:57
* 16	12 3/4	3:48	13	3:59
17	12 3/8	3:45	12½	3:56
18	15¼	3:28	15 1/8	3:24
19	12½	3:48	12 3/4	3:47
* 20	9 7/16	4:16	11¼	4:16
21	11 1/16	4:07	12	4:11
* 22	12 5/8	3:24	12½	3:32
23	12	4:03	12¼	4:13

SUBJECT NUMBER	AGE	WT. (Kg.)	MVO_2 L/min	MVO_2 ml/kg	1000 m. T1 (sec)	1000 m. T2 (sec)	12 min run T1 (meters)	12 min run T2 (meters)	V1 M/min	V2 M/min	12 min run T1 (miles)	12 min run T2 (miles)
01	19	65	2.256	35	252	278	1916	2168	159.7	180.7	1:19	1:35
02	18	65	2.569	40	214	220	2672	2773	222.7	231.1	1:66	1:72
03	19	70	2.740	39	243	240	2420	2444	201.7	203.7	1:50	1:52
04	20	75	3.511	47	196	190	2924	2930	243.7	244.2	1:82	1:82
05	19	77	3.528	46	217	216	2672	2621	222.7	218.4	1:66	1:62
06	20	68	2.864	42	229	237	2571	2646	214.3	220.5	1:59	1:64
07	20	68	3.029	45	222	212	2823	2898	235.3	241.5	1:75	1:80
08	19	75	2.920	39	218	219	2696	2672	224.7	222.7	1:68	1:66
09	18	67	2.972	44	227	231	2595	2470	216.3	205.8	1:61	1:53
10	18	77	3.047	40	197	196	3039	2998	253.3	249.8	1:89	1:86
11	19	69	2.850	41	219	221	2672	2847	222.7	237.3	1:66	1:77
12	18	70	3.773	54	208	196	3025	2998	252.1	249.8	1:88	1:86
13	18	77	3.237	42	231	238	2420	2444	201.7	203.7	1:50	1:52
14	20	78	3.280	42	228	228	2470	2595	205.8	216.3	1:53	1:61

SUBJECT NUMBER	AGE	WT. (Kg.)	MVO_2 L/min	MVO_2 ml/kg	1000 m. T1 (sec)	1000 m. T2 (sec)	12 min run T1 (meters)	12 min run T2 (meters)	V1 M/min	V2 M/min	12 min run T1 (miles)	12 min run T2 (miles)
15	18	68	2.425	36	225	237	2470	2595	205.8	216.3	1:53	1:61
16	18	77	2.907	38	228	239	2571	2621	214.3	218.4	1:60	1:63
17	19	73	3.140	43	225	236	2494	2521	207.8	210.1	1:55	1:57
18	18	61	3.243	53	208	204	3075	3049	256.3	254.1	1:91	1:89
19	19	61	2.514	41	228	227	2521	2571	207.8	214.3	1:57	1:60
20	19	84	3.073	37	256	256	1916	2269	159.7	189.1	1:19	1:41
21	19	86	3.389	39	247	251	2230	2420	185.8	201.7	1:39	1:50
22	18	82	4.127	50	204	212	2545	2521	212.1	210.1	1:58	1:57
23	18	97	3.503	36	243	253	2420	2470	201.7	205.8	1:50	1:53